FY04 Technical Program Summary

Table of Contents

Vehicle Technology Directorate -
Langley Site
US Army Research Laboratory
at
NASA Langley Research Center
Hampton, VA 23681-0001

The ARL Vehicle Technology Directorate at the Langley Research Center conducts research in two business areas:

Structural Mechanics and
Loads & Dynamics

Program areas funded under these technical competencies include basic (6.1) and applied (6.2) research in Aviation Technology and Ground Vehicle Technology. The following "Table of Contents" outlines the organization of the work packages and individual research projects within this document.

Aviation Structural Mechanics Research - 6.1 - 61102 / AH66 / VS1011

VS1011.CA03	Development of Lightweight, Low-Cost Advanced Aircraft Structural Concepts
VS1011.CA04	Computational Methods for Deployment Analysis of Lightweight Structures
VS1011.IF01	Delamination Characterization
VS1011.IF02	Composite Low-Velocity Impact Analysis and Testing
VS1011.IF03	Small Crack-Growth Effects in Metallic Materials
VS1011.IF07	Tension-Bending Behavior of Tapered Composite Laminates
VS1011.IM01	Threshold Fatigue Crack Growth of Metallic Materials
VS1011.IN01	Damage Initiation and Growth in Composite Structures

Aviation Loads & Dynamics Research - 6.1 - 61102 / AH66 / VS1015

VS1015.AL05	Aeroelastic Modeling of Advanced Rotor Configurations
VS1015.AL06	High Performance Piezoelectric Actuator Development
VS1015.AL07	Lightweight Multifunctional Structural Components Development
VS1015.AL08	Fuselage Dynamics and Tail Buffet
VS1015.AR01	Structural and Material Characteristics of Biological Morphologies
VS1015.DC01	Crashworthiness of Composite Frames and Floor Sections
VS1015.DR14	Modeling of Thin Membrane Structures

Ground Vehicle Loads & Dynamics Research - 6.1 - 61102 / AH42 / VS1016

VS1016.DC02	Nonlinear Mechanics of Elastomeric and Composite Structures

Aviation Structural Mechanics Technology - 6.2 - 62211 / A47B / VS2011

VS2011.CA02	SARAP Crash Safety Research Program
VS2011.CD01	Damage Initation and Growth Studies in Tailored Laminates
VS2011.IC02	Skin/Stiffener Debonding Analysis Methods
VS2011.IC03	Exploratory Research on Adaptive Sensors for Composite Rotorcraft
VS2011.IC04	Failure of Rigid Foams
VS2011.IF04	Z-pin Reinforcement Analysis
VS2011.IF08	Fatigue Life Methodology of Metallic Rotorcraft Dynamic Components
VS2011.IF11	Impact Damage Resistance & Tolerance of Thin Skin Composite Sandwich Structure
VS2011.IF12	Reliability-Based Design Methods
VS2011.IN01	Composite Thermal Nondestructive Evaluation
VS2011.IN07	SARAP NDE/Reparability Program

Ground Vehicle Structural Mechanics Technology - 6.2 - 62105 / AH84 / VS2012

VS2012.CA01	Research on Ground Combat Vehicles
VS2012.CA02	Buckling - Vibration Interaction
VS2012.CA03	Analysis of Structural Joints for Ground Vehicles
VS2012.CA04	Inflatable Structures
VS2012.CD01	Selective Reinforcement of Aluminum Structures
VS2012.CD02	Multi-Functional Structures
VS2012.IN07	NDE of Composite Structures Using Laser Ultrasonics
VS2012.IN12	NDE of Electrical Wire Insulation Using Ultrasonics

Aviation Loads & Dynamics Technology - 6.2 - 62211 / A47B / VS2015

VS2015.AA02	High-Speed Aeroelastic Research Models
VS2015.AE03	High-Voltage Electrical Systems
VS2015.AL04	Experimental Investigation of Active Twist Rotor Concepts for Vibratory Load Reductio
VS2015.AL05	Analysis and Design of Active Twist Rotor Blades
VS2015.DC08	Innovative Composite Fuselage Design for Improved Crashworthiness
VS2015.DC09	Soft Soil - Water Impact
VS2015.DC11	Crash Simulation of an ATR42 Aircraft
VS2015.DT01	Applications of Structural Tailoring Concepts

Ground Vehicle Loads & Dynamics Technology - 6.2 - 62105 / AH84 / VS2016

Date Last Modified: 05-JAN-04

BUSINESS SUBAREA:	6.1		STRUCTURAL MECHANICS	
PE/PRJ/WP#/WP:	61102	AH66	VS1011	Aviation Structural Mechanics Research
DIRECTORATE/DIVISION	ARL Vehicle Technology Directorate		Structural Mechanics	
POC/PHONE:	Dr. F. D. Bartlett, Jr.	(757) 864-3952		

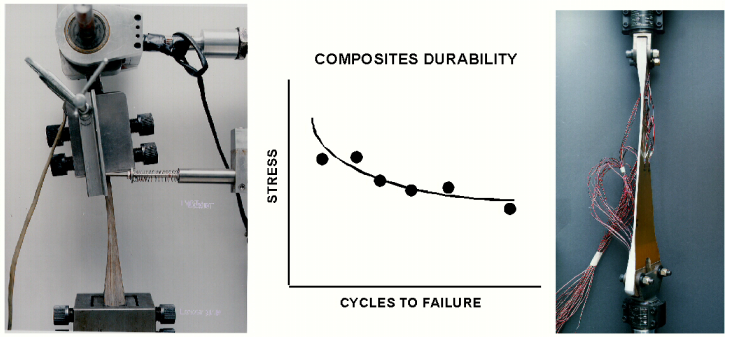
THRUST:

Fundamental structural mechanics research in failure mechanisms, damage progression, residual strength, and fatigue durability of metallic and composite rotorcraft structures to advance new and innovative analysis methods and design criteria.

Validated analytical, testing, and measurement science tools for an integrated stress-strength-inspection technology to extend the life of existing and reliability/durability of future Army vehicles and structures.

OBJECTIVES:

* Develop advanced structural analysis methods and validate design tools for composite/hybrid structures.
* Establish composite delamination failure criteria to predict onset and progression of damage, fatigue durability, and damage tolerance.
* Develop advanced NDE sciences for accurate and efficient nondestructive inspection of composite/hybrid structures.
* Transfer basic structural mechanics research knowledge and sciences to AMCOM and industry through TPAs, STOs, and CRDAs.



PROGRAM SCHEDULE:

RESEARCH STUDIES	2003	2004	2005	2006	2007
Lightweight, Low-Cost Adv AC Structural Concepts	▪▪▪▪	▪▪▪▪	▪▪▪▪		
Comp. Methods for Deployment Anal. of L/W Structures		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Delamination Characterization	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Composite Low-Velocity Impact Analysis and Testing	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Small Crack-Growth Effects in Metallic Materials	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Tension-Bending Behavior of Tapered Composites	▪▪▪▪	▪▪▪▪			
Threshold Fatigue Crack Growth of Metallic Materials	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Damage Initiation and Growth in Composite Structures		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

FY04 KEY DELIVERABLES:

* Conduct analyses to identify optimal stacking sequence and weight for a given buckling and postbuckling responses.
* Develop large displacement formulation for pressurized fabric airbeam structures.
* Conduct fatigue tests of Mode I DCB specimens. Develop & initiate Round Robins for Mode II and Mixed Mode I & II tests.
* Initiate impact damage tolerance research on structures made with skins of sparsely-placed materials.
* Develop, refine and evaluate performance of small-crack monitoring system.
* Document delamination growth rates for one specimen using digital images taken during the testing.
* Expand existing crack closure model to include the effects of deformable crack mouth corrosion products.
* Verify destructive and non-destructive methods for quasi-isotropic laminates under static loading.

This chart covers Fiscal Year 2004

Business SUBAREA:	6.1		STRUCTURAL MECHANICS	
PE/PRJ/WP#/WP:	61102	AH66	VS1011	Aviation Structural Mechanics Research

Workyears	2003	2004	2005	2006	2007
ARMY	1.9	3.4	3.9	4	4.6
NASA	.2	.8	.8	.8	.8
OTHER	.3	.7	.4	.4	.4

STRUCTURAL MECHANICS

OBJECTIVE

The objective of Workpackage VS1011 is to develop advanced structural analyses, failure criteria, and inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures. The focus of the current S&T is on the development of design tools for manned and unmanned rotorcraft composite hub and fuselage applications, and advanced fatigue methodologies for the life extension of metallic structures The long-term goal is to provide an integrated stress-strength-inspection technology for life extension of existing and durability of future Army aviation vehicles.This Workpackage provides basic understanding of structural deformations, damage mechanisms, and damage progression. This fundamental knowledge augments and transitions to on-going applied research activities and supports the DoD Rotary Wing Vehicle structures technical objectives.

APPROACH

Analytical and experimental basic research is conducted through in-house and cooperative efforts, leveraging NASA facilities and technology relevant programs. The focus of this work addresses structural integrity deficiencies to improve: (1) inaccurate/inefficient stress analysis capabilities for composite structures and hybrid structures with complex geometries; (2) fatigue and fracture analyses for metallic and composite structures; (3) test and analysis methods for characterizing composite delaminations and developing uniform failure criteria; (4) low velocity impact analysis and test capabilities for quantifying damage resistance; and (5) nondestructive measurement sciences for inspecting flaws and damage in thin composite structures. Specific goals of this basic research are to: reduce errors in stress analysis, improve accuracy of composites fatigue models, and to reduce inspection times for composite/hybrid structures. There is considerable interaction with Army Research Office core technologies and the NRTC sponsored Rotorcraft Centers of Excellence. In addition, VTD participates in international MOUs and conducts joint research with the US helicopter industry through Cooperative Research and Development Agreements (CRDAs). Relevant structural mechanics technology is directly transferred to the rotorcraft design community. There is substantial connectivity and leverage with NASA core research and focus programs. Finally, the Army activities support and leverage international collaborative programs such as The Technical Cooperation Program (TTCP).

SIGNIFICANCE

The technology benefit of this Army basic research in structural integrity will be more accurate, more efficient, and more reliable design tools and inspection methods for composite structures. This joint Army/NASA research provides validated analytical tools and a fundamental understanding of structural integrity issues for manned and unmanned rotorcraft structures. These advances in vehicle structural mechanics will enable composites to be used for the low weight, high performance capabilities needed for future Army rotorcraft structures. The ultimate payoff will be more reliable, more durable, safer and more affordable Army air vehicles.